I-CAR ADVANTAGE

TECHNICAL INFORMATION FOR THE COLLISION INDUSTRY

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Chemical Health Hazards

Chemicals commonly used in the collision repair industry can be hazardous to your health, and to the environment. An article in the March/April 1992 issue of the *Advantage* discussed handling wastes that are hazardous to the environment. This article discusses the types of chemicals that are hazardous to personal health.

Most of the health-hazardous chemicals found in a shop are in five gallon or smaller containers. Anyone using these chemicals must realize that it is not the amount of chemical that is dangerous, but the hazard that it poses.

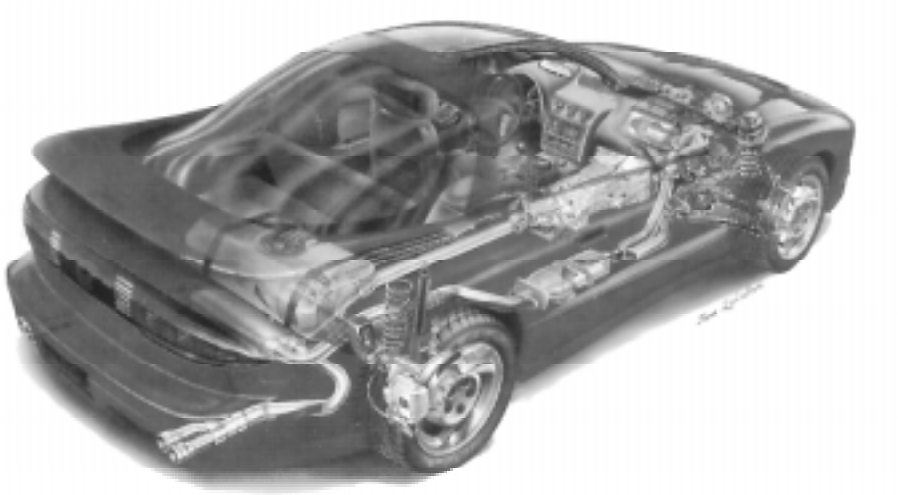
The Occupational, Safety and Health Administration (OSHA) has identified 16 hazard classes. Of these, eight are commonly found in collision shops. They include:

- irritants
- corrosives
- central nervous system toxins (neurotoxins)
- carcinogens (cancer-causing agents)
- hepatotoxins (liver toxins)
- hemoglobin or blood toxins
- reproductive toxins
- allergenics

Before discussing the different classes of chemicals, let's look at

Continued–Page 5

New Camaro/Firebird –New Features, New Repair Methods



This phantom view of the Firebird Trans Am shows the short/long arm (SLA) suspension system and passenger side air bag. Note that the front spring and shock assembly is above the upper control arm. Although this looks like a strut assembly, it's actually a new variation of GM's SLA design.

The 1993 Camaro and Firebird have many new features compared to the old GM F-body. GM engineers also kept repairability in mind as they developed these cars. The F-body is a space-frame structure, with most of the exterior panels either RRIM or SMC. These rearwheel-drive cars have standard driver and passenger-side air bags, as well as anti-lock brakes. The Camaro Z-28, Firebird Formula, and Firebird Trans Am models come with four-wheel anti-lock disc brakes.

These new cars feature doors, roof, rear hatch panel, rear spoiler, and rear closeout panel all of SMC, mounted on a galvannealed steel space frame. The fenders, and front and rear bumper fascias are RRIM. Except for the door intrusion beams and front bumper beams, there are no high-strength or ultra-high strength steel parts *(see Figure 1).*

Repairability of these cars is improved because GM provides specific sectioning guidelines and templates for the upper front rail and door opening, and other templates for special hole locations. These guidelines and templates are covered in a detailed body repair manual. They will also be shipped with some service parts. In addition to standard repair skills and procedures, upper body measuring equipment will be needed in order to properly align the formed and pierced points.

Continued–Page 2

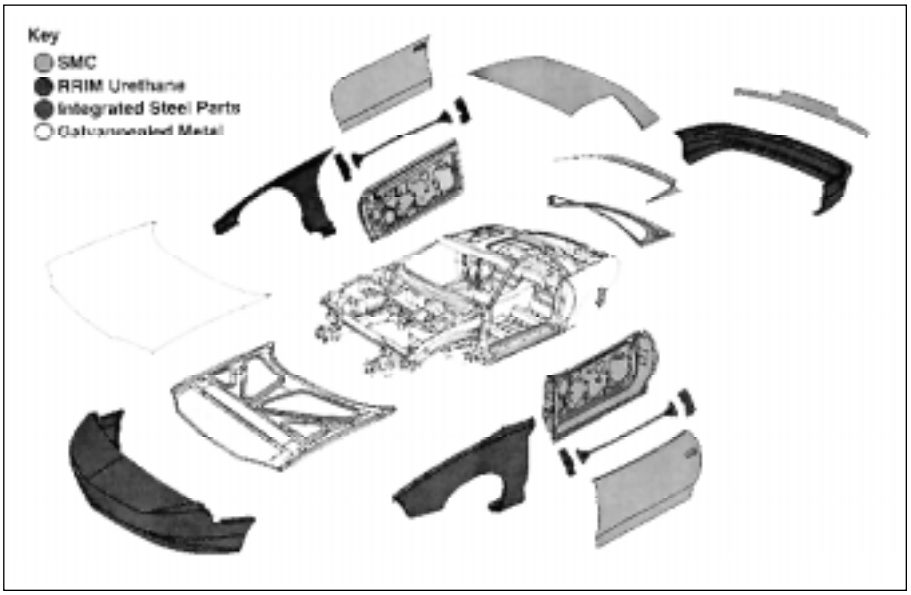


Figure 1–The new F-body is a space frame structure, with outer panels made of SMC and RRIM.

DESIGNED FOR REPAIRABILITY

Radiator Core Support

The radiator core support is available either as a complete unit or as four separate pieces. Replacing the core support is less complicated on the new model, because the attaching surfaces are readily accessible.

Front And Rear Rails

Replacing the lower front rails is also much easier compared to the old F-body. The front lower rails are straighter, and they are available as a unit, with all brackets and reinforcements *(see Figure 2).* The outer side-rail extensions are also available as service parts. GM recommends replacing the lower front rails and the rear rails, if they are damaged severely.

The upper, inner front rails may be sectioned, using the information found in the body repair manual. The upper, outer rails must be removed prior to sectioning the inner rails. Then the existing rails are marked for cutting. Cutting the inner rails for sectioning must be done carefully to prevent cutting into adjacent panels. Templates are provided with the service parts to help make accurate cuts *(see Figure 3).* Once the inner rails are separated from the cowl, the remaining spot welds can be drilled out.

The upper, inner front service rails come pre-cut for an overlap of $1^{3}/_{8}$" (35mm). Nine $^{5}/_{16}$" (8mm) plug-weld holes are pre-drilled along the overlap, to secure the rail section. The seams are welded with 1" (25mm) welds, then the rest of the plug welds are completed.

The upper rail has formed and pierced holes in its upper edge. These special holes serve a similar purpose to the mill and drill pads on the GM APV vans. They are formed during the manufacturing process, and their locations must be maintained during the repair. All measurements are read from the formed surfaces and the center of the holes *(see Figure 4).*

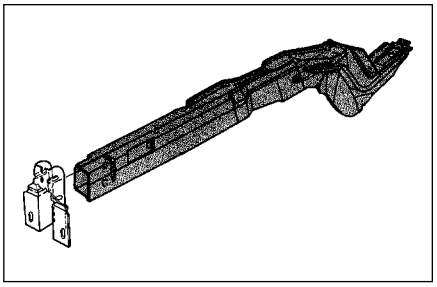


Figure 2–The lower front rail is available as a unit. GM recommends replacing rather than sectioning the lower rails.

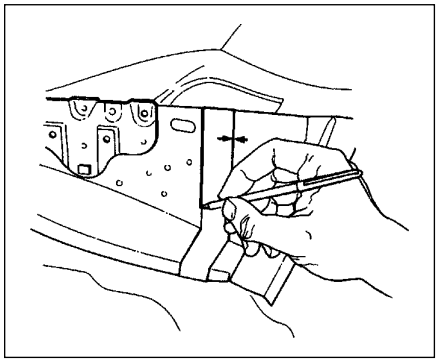


Figure 3–GM provides a template to help scribe and cut the upper inner front rail for sectioning. Note the arrows on the template and replacement part used to align the template.

The replacement upper, outer rail is flat, not formed. The formed surfaces are made by using special clips and washers with adhesive backings. The washers are used as shims for positioning the hood-to fender gap. Use only the service kit washers supplied with the rails (GM part number 12520407). These parts hold the fender mounting bolts in place. Installation of the clips and washers must be performed before welding *(see Figure 5).*

I-CAR ADVANTAGE

TECHNICAL INFORMATION FOR THE COLLISION INDUSTRY

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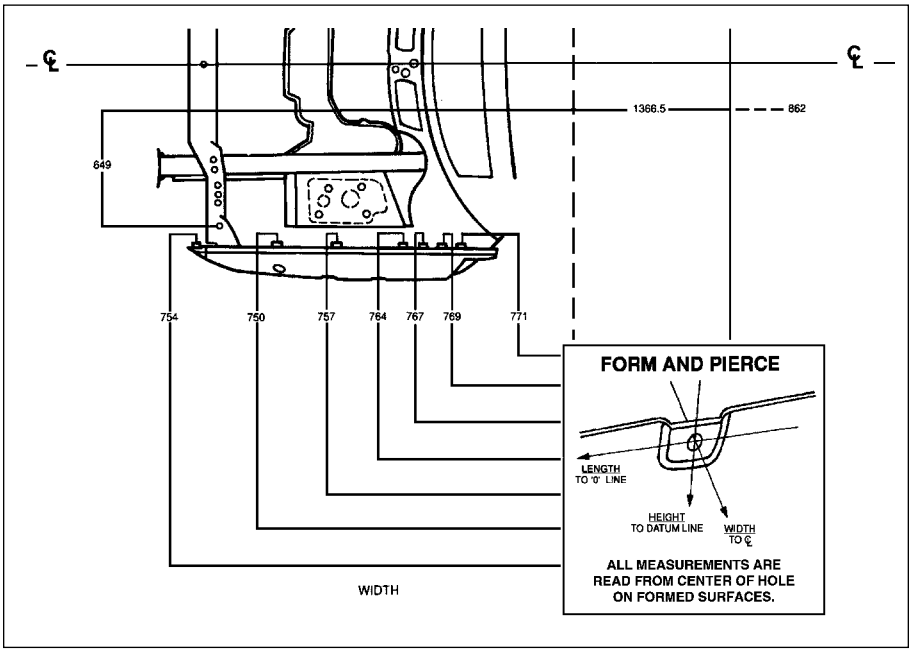

Figure 4–All measurements on the upper rail are read from the special formed and pierced holes.

Door Opening Frame

Specific sectioning guidelines are provided for the one-piece, door-opening frame. The service part comes as a complete unit and must be trimmed to fit each application. Part of the door-opening frame will have to be cut out to fit T-top models, using the template provided. *Figure 6* shows two recommended sectioning locations. A lap joint is recommended which extends about 3/4" (20mm) beyond the original panel.

There are five places in the door-opening frame which should NOT be sectioned *(see Figure 7).* Sectioning in these areas may affect the structural integrity of the vehicle in side impacts or rollovers.

In areas having no internal reinforcement, a butt weld with backing (sleeve joint) may be used. The backing should extend 1 1/2" (38mm) beyond each side of the joint. Backing pieces can be cut from the damaged panel or from the unused portion of the new panel.

Suspension Mountings

The front wheelhouse assemblies are available with all attaching reinforcements and brackets. The front wheelhouse aprons are also available separately. The mounting holes must be drilled by the technician. GM is supplying a template in the service kit to help locate and drill these holes *(see Figure 8).* The holes are pierced during vehicle assembly, and thus are not available on the service part.

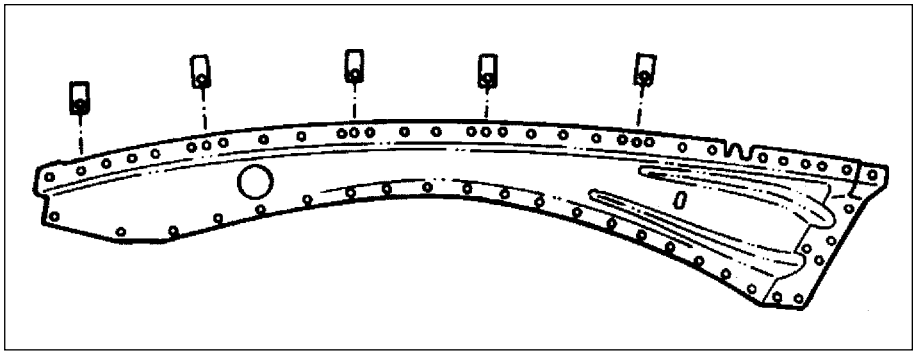

Figure 5–When replacing the upper rail, special J-clips must be installed before welding. These clips hold the fender mounting bolts in place.

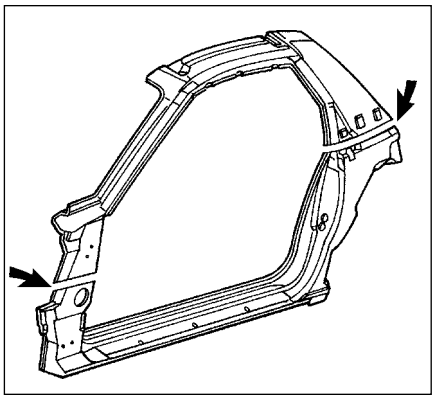

Figure 6–GM provides sectioning recommendations for the door-opening frame, particularly at these two locations.

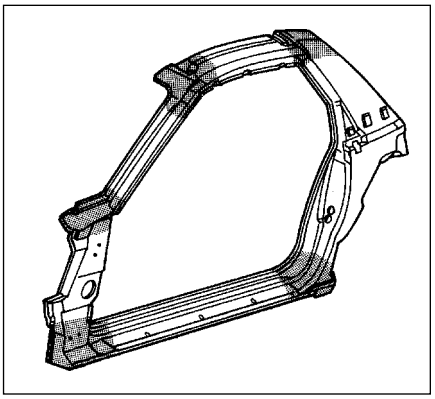

Figure 7–GM recommends against sectioning at the shaded areas, to preserve the structural integrity in side impacts and rollovers.

Quarter Panel

Quarter panel replacement on the new F-bodies is quite different. There are special instructions for removing the top and bottom of the quarter panel. The quarter panel should not be sectioned, but should be replaced at factory seams.

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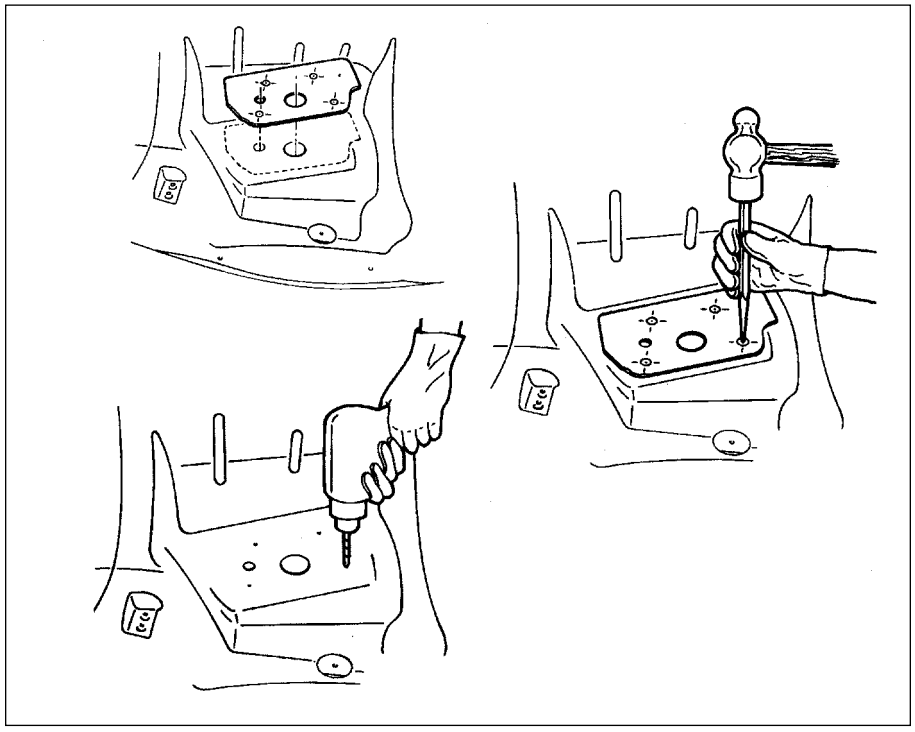

Figure 8–The technician needs to drill the attaching holes to mount a replacement upper control arm. A template is provided to locate and drill the holes.

The SMC roof-panel adhesive must be cut away so that the bottom of the panel can be lifted to get at the spot-weld seam *(see Figure 9).* The roof panel is held out of the way with a block of wood so that the spot welds can be drilled out. Use caution to avoid lifting the roof panel too far. As *Figure 9* shows, it's possible to damage the roof panel if too much lifting force is applied.

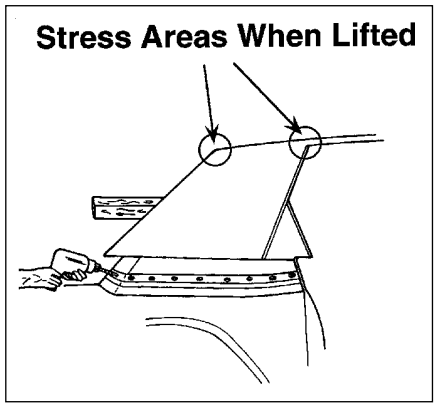

Figure 9–Replacing of the quarter panel requires cutting the SMC roof panel adhesive and holding the panel up with a block of wood to reveal the spot weld locations. The roof shouldn't be lifted too high, as it can be damaged at the two areas shown.

Each quarter panel is installed by aligning and welding the bottom seam first, as seen in *Figure 10.* The rest of the quarter panel is then aligned, and the welding completed. The next step is to rebond the roof panel to the quarter. Any bare steel must be coated with a two-part epoxy or self-etching primer. Remove loose adhesive, prime, and rebond with approved urethane adhesive (GM part number 12345633). SMC repairs to the exterior panels are the same as those recommended for the exterior panels on the GM APV vans (see the November-December 1989 issue of the *Advantage* and the *I-CAR Plastic Repair Course).*

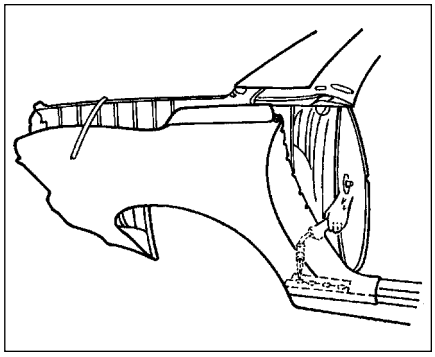

Figure 10–To assure alignment of the quarter panel, the bottom seam is welded first. The upper quarter panel assembly must be held away from the vehicle while drilling out the holes and during welding.

CAUTIONS ON THE USE OF HEAT

The use of heat is not recommended for straightening purposes. If heat must be used, do not exceed 1000°F (538°C), and do not apply heat for more than 2 minutes. Keep in mind that severe kinks, tears, or cracks in the main structural parts will require complete replacement or sectioning.

The lower front rails are made from the thickest metal of any panel on the vehicle. Due to the thickness of the lower front rail, GM recommends against using a 115-volt MIG welder. The redesigned, one-piece door-opening frame, and lower front rail contribute to a stiffer chassis.

CONCLUSION

The new F-body does not introduce any new materials. Steel, SMC and plastic are easily repaired if you have the right skills and training. However, there are new repair procedures that are specific to these cars. These procedures, along with sectioning guidelines and templates, are included in the new F-body repair manual. This manual is a necessary tool when working on these vehicles. Review a copy before attempting any of the repairs described in this article. It will make your job a lot easier. This manual is available from:

Helm, Inc.
Manual Distribution Dept.
P.O. Box #07130
Detroit, MI 48207
or call (313) 865-5000.

Illustrations in this article courtesy of General Motors.

how chemicals enter the body, and the different levels of exposure that are possible.

ROUTES OF ENTRY

For a hazardous chemical to be harmful, it must enter the body. This is called "route of entry." There are four main routes of entry:

- inhalation (breathing)
- ingestion (swallowing)
- absorption (skin)
- injection (skin)

Inhalation, or breathing, is the most common route of entry. The human body must breathe between 12 and 20 times per minute. Chemicals may produce vapors or dust particles during storage, or when they are being poured or mixed. Airborne chemicals will enter your body through the respiratory system and be absorbed into the blood stream.

The second most common route of entry is **ingestion.** Of course, you wouldn't intentionally eat hazardous chemicals. However, poor hygiene may allow chemicals to enter your system through your digestive tract. That's why it's important to wash your hands after using hazardous chemicals. Also, eating and drinking should be avoided in an area where chemicals are used.

Solvents and thinners pose a particular problem with the third route of entry, **absorption.** Solvents break down oils, which are the protective barrier of the skin. As the solvents break down and remove the oil, they are able to pass through the skin into the blood stream.

Injection is another route of entry. Injection exposure occurs when the skin is broken by cuts, abrasions, or a skin rash, allowing the hazardous chemical to enter. Also, air powered tools or cleaning equipment can force or inject chemicals directly through the skin into the body by pressure.

LEVELS OF EXPOSURE

How long does it take before you know if you have been exposed to a hazardous chemical? It depends on your level of exposure. If you were exposed to a large amount of chemical during a short period of time, the effects will occur almost immediately. This is called an **acute** exposure. You can also be exposed to a large amount of chemical in which the symptoms will not be evident immediately. This is called a **sub-chronic** exposure. If you were exposed to small amounts of a chemical over a long period of time, the effects may take ten years or more to become evident. This is called a **chronic** exposure.

TYPES OF HAZARDOUS CHEMICALS

Irritants

Irritants are chemicals that cause irritation to skin, eyes, and mucous membranes. They are usually just annoying. But they can cause permanent damage, like dermatitis or eye infections. If an irritant enters the lungs, it may be life threatening. There are three types of lung irritants:

- **Upper respiratory:** These are water soluble and affect the upper respiratory system like the nose and throat.
- **Middle respiratory:** These chemicals are slightly water soluble and affect the upper and middle respiratory system. They can produce wheezing, coughing, and respiratory distress.
- **Lower respiratory:** These are not soluble in water. They travel deep into the lung and often cause fatal respiratory disease.

Some common products found in collision repair shops may contain lower or fatal respiratory irritants. These include:

- midtemp reducers
- lacquers
- adhesives
- base thinners/reducers
- enamel hardeners/reducers
- activators
- rubberized undercoatings

Corrosives

Corrosives are acid or alkaline products. They can cause burns to the skin. These chemicals are found in many cleaning products and metal preparations. They may also be classified as upper and middle respiratory irritants. Note that many chemical products can have more than one type of hazard.

Central Nervous System Toxins (Neurotoxins)

The central nervous system includes your brain, spinal cord and nerves. Neurotoxin chemicals can destroy nerve endings and hurt your judgment, coordination and vision. Neurotoxins may also produce headaches, dizziness and nausea *(see Figure 1).* Many of the hydrocarbon products used in the collision repair industry contain neurotoxins that can cause problems over time. Products containing neurotoxins include:

- lacquers
- adhesives

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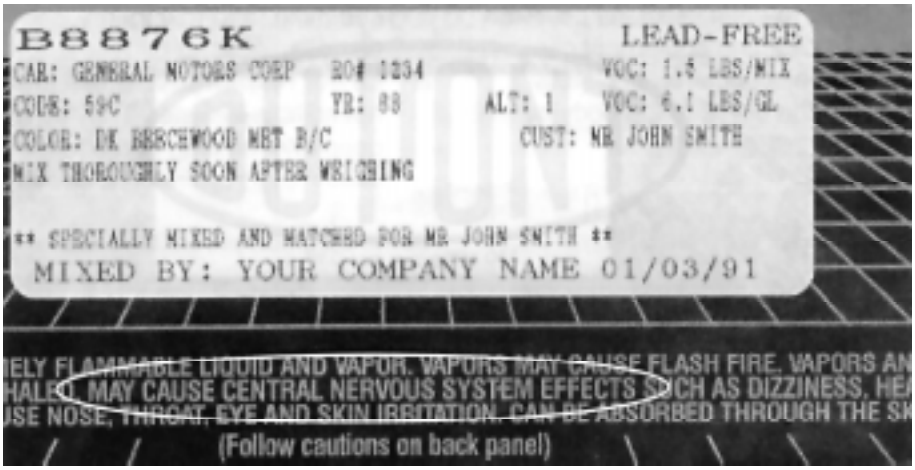


Figure 1–This warning label from a can of paint shows the effects of the neurotoxins contained in the paint.

- base thinners/reducers
- chip-resistant coatings
- disc adhesives
- blending clears

Carcinogens (Cancer-Causing Agents)

Some chemicals may cause cancer. Materials found in the shop that contain chemicals known to cause cancer include asbestos and any product containing silicon. Asbestos may be found in some styles of brake shoes. Always wear proper protection to prevent breathing any free-floating asbestos fibers. Also, protect yourself when using any product containing silicon. This is because silicon can cause a type of lung cancer called *silicosis,* which is very difficult to treat. Carcinogen exposure falls into the chronic exposure category.

Hepatotoxins (Liver Toxins)

The liver may be harmed by a number of chemicals, called hepatotoxins *(see Figure 2).* Liver damage can be life threatening. Like carcinogens, hepatotoxins fall into the chronic exposure category. Pouring, mixing, and applying some products may expose you to this type of risk. Common products that contain liver toxins include:

- lacquers
- lacquer retarders
- urethane enamels
- adhesives

Liver damage cannot be detected until the later stages of the disease, so protect yourself from exposure at all times.

Hemoglobin (Blood) Toxins

Poisons that affect and destroy the blood cells are called hemoglobin toxins. Hemoglobin is the red part of red blood cells. Its main function is to carry oxygen to all cells of the body. These toxins may cause an acute, sub-chronic, or chronic exposure, depending on the amount of toxins you are exposed to and the concentration. Blood toxins may harm blood cells in two different ways. One way is to stick to the red blood cells, forcing the oxygen out. This slowly lowers the oxygen available for the other cells. Another way blood toxins may work is to deform the red blood cells so their ability to carry oxygen is reduced. Symptoms of the condition include difficulty breathing, and loss of consciousness. Common products containing hemoglobin toxins include:

- blending clears
- enamel clearcoats
- hardeners
- retarders

Reproductive Toxins

Reproductive toxins may cause birth defects through chronic exposure. Birth defects can vary from minor to very severe. Products that may produce birth defects include:

- acrylic lacquers
- urethane enamels

HEALTH HAZARD DATA

Eye contact:	Liquid and vapor may cause irritation.
Skin contact:	May cause irritation.
Inhalation:	May cause respiratory system irritation. Chronic exposure may cause nervous system impairment, liver and kidney damage. Symptoms may include dizziness, nausea, headache, vomiting, incoordination, confusion, drowsiness and coma.
Ingestion:	Aspiration into the lungs may cause lung damage. May cause digestive system irritation. Chronic exposure may cause nervous system impairment, liver and kidney damage. Symptoms may include dizziness, headache, vomiting, diarrhea, incoordination, drowsiness and coma.

Figure 2–This listing of health hazard data for a flexible parts coating product shows that the product contains chemicals which can cause liver damage.

- midtemp reducers
- blending clears

Allergenics

Many people are allergic to certain chemicals. The technical name for such allergies is *anaphylaxis.* The reaction is similar to that of an allergic person who gets stung by a bee. The respiratory tract is the first affected, as it becomes swollen. Allergic reactions normally do not occur on the first exposure to a chemical. The first exposure will set up a chain of events in your body that will react when you receive the second exposure. Further exposures will cause more symptoms.

It's very hard to identify which chemicals may cause this type of reaction. Every person is different, and will react differently to these types of chemicals. Some chemicals that may cause these types of reactions include:

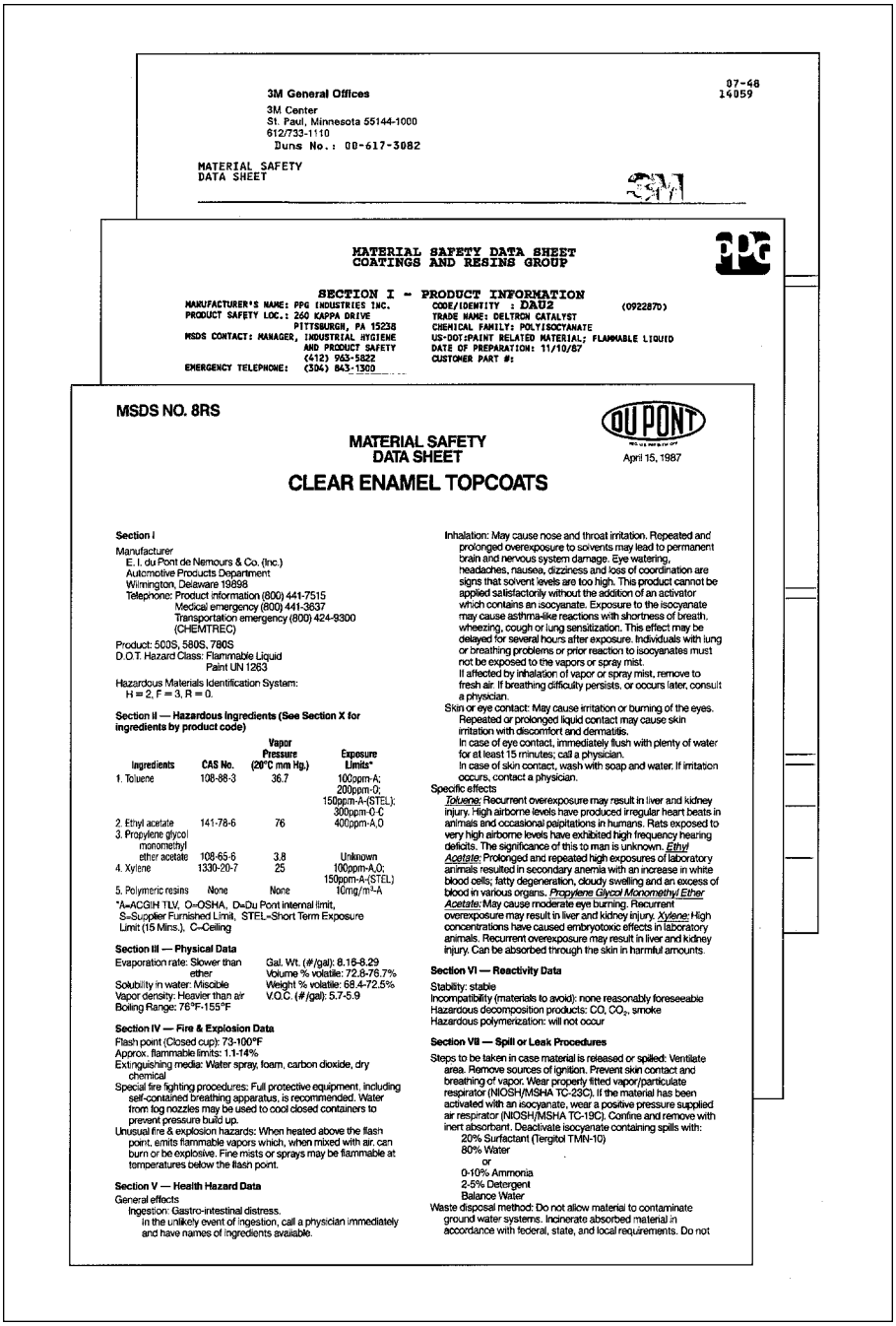
- acrylic urethane enamels
- adhesives
- sealers
- clearcoats
- hardeners
- activators

CONCLUSION

There are many chemical risks associated with working in the collision repair field, and protection is necessary. These chemicals cannot be taken out of the work place. They are a part of your business and must be used to produce an acceptable finished product.

Everyone working in the shop should be trained on the proper method of chemical use and storage. A formal program is required for any shop with more than 12 employees, under the 1983 OSHA Hazard Communication Law, or the Employee Right To Know Law. Such a program teaches employees how to read Material Safety Data Sheets (MSDS) that, by law, are included with the purchase of products containing hazardous chemicals *(see Figure 3).* The MSDS provides necessary information on personal protective equipment and all of the health hazards associated with that particular chemical. Becoming aware of this information, and educating yourself on the hazards of the chemicals you use everyday, is a good idea for any size shop. A

Information for this article courtesy of Corptrain, Chicago.



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3M Center
St. Paul, Minnesota 55144-1000
612/733-1110
Duns No.: 00-617-3082

07-48
14059

MATERIAL SAFETY
DATA SHEET

MATERIAL SAFETY DATA SHEET
COATINGS AND RESINS GROUP

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME: PPG INDUSTRIES INC.
PRODUCT SAFETY LOC.: 260 KAPPA DRIVE
PITTSBURGH, PA 15238
MSDS CONTACT: MANAGER, INDUSTRIAL HYGIENE
AND PRODUCT SAFETY
(412) 963-5822
EMERGENCY TELEPHONE: (304) 843-1300

CODE/IDENTITY : DAU2 (092287D)
TRADE NAME: DELTRON CATALYST
CHEMICAL FAMILY: POLYISOCYANATE
US-DOT:PAINT RELATED MATERIAL; FLAMMABLE LIQUID
DATE OF PREPARATION: 11/10/87
CUSTOMER PART #:

MSDS NO. 8RS

MATERIAL SAFETY
DATA SHEET

April 15, 1987

CLEAR ENAMEL TOPCOATS

Section I

Manufacturer
E. I. du Pont de Nemours & Co. (Inc.)
Automotive Products Department
Wilmington, Delaware 19898
Telephone: Product information (800) 441-7515
Medical emergency (800) 441-3637
Transportation emergency (800) 424-9300
(CHEMTREC)

Product: 500S, 580S, 780S
D.O.T. Hazard Class: Flammable Liquid
Paint UN 1263

Hazardous Materials Identification System:
H = 2, F = 3, R = 0.

Section II — Hazardous Ingredients (See Section X for ingredients by product code)

Ingredients	CAS No.	Vapor Pressure (20°C mm Hg.)	Exposure Limits*
1. Toluene	108-88-3	36.7	100ppm-A; 200ppm-0; 150ppm-A-(STEL); 300ppm-0-C
2. Ethyl acetate	141-78-6	76	400ppm-A,0
3. Propylene glycol monomethyl ether acetate	108-65-6	3.8	Unknown
4. Xylene	1330-20-7	25	100ppm-A,0; 150ppm-A-(STEL)
5. Polymeric resins	None	None	10mg/m³-A

*A=ACGIH TLV, O=OSHA, D=Du Pont internal limit, S=Supplier Furnished Limit, STEL=Short Term Exposure Limit (15 Mins.), C=Ceiling

Section III — Physical Data

Evaporation rate: Slower than ether
Solubility in water: Miscible
Vapor density: Heavier than air
Boiling Range: 76°F-155°F
Gal. Wt. (#/gal): 8.16-8.29
Volume % volatile: 72.8-76.7%
Weight % volatile: 68.4-72.5%
V.O.C. (#/gal): 5.7-5.9

Section IV — Fire & Explosion Data

Flash point (Closed cup): 73-100°F
Approx. flammable limits: 1.1-14%
Extinguishing media: Water spray, foam, carbon dioxide, dry chemical
Special fire fighting procedures: Full protective equipment, including self-contained breathing apparatus, is recommended. Water from fog nozzles may be used to cool closed containers to prevent pressure build up.
Unusual fire & explosion hazards: When heated above the flash point, emits flammable vapors which, when mixed with air, can burn or be explosive. Fine mists or sprays may be flammable at temperatures below the flash point.

Section V — Health Hazard Data

General effects
Ingestion: Gastro-intestinal distress.
In the unlikely event of ingestion, call a physician immediately and have names of ingredients available.
Inhalation: May cause nose and throat irritation. Repeated and prolonged overexposure to solvents may lead to permanent brain and nervous system damage. Eye watering, headaches, nausea, dizziness and loss of coordination are signs that solvent levels are too high. This product cannot be applied satisfactorily without the addition of an activator which contains an isocyanate. Exposure to the isocyanate may cause asthma-like reactions with shortness of breath, wheezing, cough or lung sensitization. This effect may be delayed for several hours after exposure. Individuals with lung or breathing problems or prior reaction to isocyanates must not be exposed to the vapors or spray mist.
If affected by inhalation of vapor or spray mist, remove to fresh air. If breathing difficulty persists, or occurs later, consult a physician.
Skin or eye contact: May cause irritation or burning of the eyes. Repeated or prolonged liquid contact may cause skin irritation with discomfort and dermatitis.
In case of eye contact, immediately flush with plenty of water for at least 15 minutes; call a physician.
In case of skin contact, wash with soap and water. If irritation occurs, contact a physician.
Specific effects
Toluene: Recurrent overexposure may result in liver and kidney injury. High airborne levels have produced irregular heart beats in animals and occasional palpitations in humans. Rats exposed to very high airborne levels have exhibited high frequency hearing deficits. The significance of this to man is unknown. *Ethyl Acetate:* Prolonged and repeated high exposures of laboratory animals resulted in secondary anemia with an increase in white blood cells; fatty degeneration, cloudy swelling and an excess of blood in various organs. *Propylene Glycol Monomethyl Ether Acetate:* May cause moderate eye burning. Recurrent overexposure may result in liver and kidney injury. *Xylene:* High concentrations have caused embryotoxic effects in laboratory animals. Recurrent overexposure may result in liver and kidney injury. Can be absorbed through the skin in harmful amounts.

Section VI — Reactivity Data

Stability: stable
Incompatibility (materials to avoid): none reasonably foreseeable
Hazardous decomposition products: CO, CO_2, smoke
Hazardous polymerization: will not occur

Section VII — Spill or Leak Procedures

Steps to be taken in case material is released or spilled: Ventilate area. Remove sources of ignition. Prevent skin contact and breathing of vapor. Wear properly fitted vapor/particulate respirator (NIOSH/MSHA TC-23C). If the material has been activated with an isocyanate, wear a positive pressure supplied air respirator (NIOSH/MSHA TC-19C). Confine and remove with inert absorbant. Deactivate isocyanate containing spills with:
20% Surfactant (Tergitol TMN-10)
80% Water
or
0-10% Ammonia
2-5% Detergent
Balance Water
Waste disposal method: Do not allow material to contaminate ground water systems. Incinerate absorbed material in accordance with federal, state, and local requirements. Do not

Figure 3–Examples of Material Safety Data Sheets (MSDS) which must be included with every product that contains hazardous chemicals.

Finding Technical Information –Several Choices Are Available

I-CAR classes teach that the repair manual for the vehicle you're working on is one of the most valuable tools in making a good repair. Troubleshooting electronic problems, for example, requires looking at specific wiring diagrams, part locator diagrams, and flow charts. Repairing other systems also requires checking specifications for the parts on the particular vehicle. As your knowledge and the complexity of vehicles increase, the need for more diagrams and specifications will also increase.

But where do you find all of these diagrams and manuals? It takes a major investment and a large space to buy and store one manufacturer's collection of manuals. The problem is worse for an independent shop. As the number of wiring diagrams increased, several manufacturers created separate electrical manuals, but you would still need to buy all of them every year to cover all vehicles.

Fortunately, there are alternatives to buying separate service manuals for each vehicle you work on. These alternatives include:

- compilation manuals
- microfiche
- CD-ROM
- modem services
- hotlines
- local dealerships

Let's take the example of wiring diagrams and part locator diagrams, and look at the pros and cons of using each of these possible sources.

COMPILATION MANUALS

Subscribing to an independent source of compilation manuals is one step short of buying separate OEM service manuals. Some publishers downsize direct copies of the OEM service manual diagrams *(see Figure 1).* Others both resize and redraw the original wiring diagrams on a computer drawing system, using one standard form. No matter what style and abbreviations are used by the various manufacturers, these redrawn wiring diagrams look the same.

As vehicles become more complex, and the size of service manuals gets larger, so must the size of the compilation manuals. For example, one company used to include wiring diagrams with other service information in books released every two years. Now, the same company prints three separate, 2,500-page volumes every year of just wiring diagrams for *GM, Ford/Chrysler, and Imports.* That doesn't include part locator diagrams, which are in separate books.

An advantage of owning a set of compilation manuals is that the

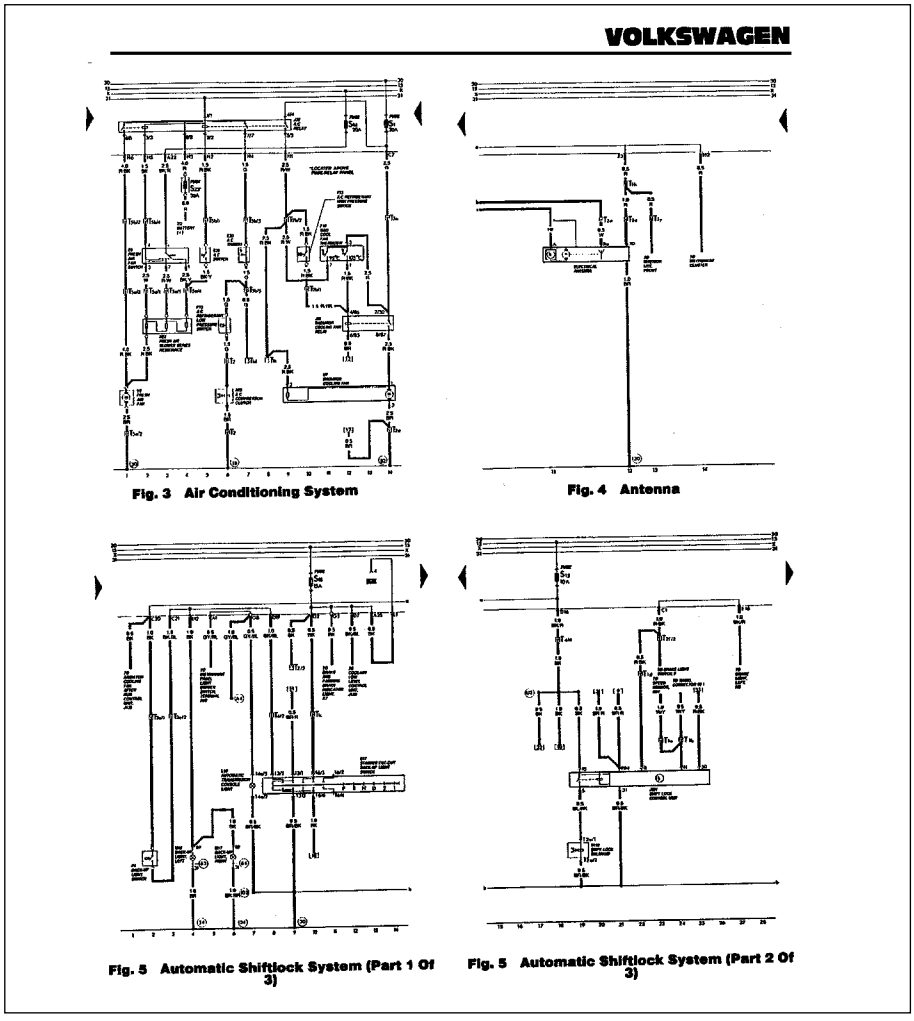

Figure 1–Two of the sources of compilation manuals downsize copies of OEM service manual wiring diagrams. Part locations are in listings, and also illustrated in separate volumes. (Courtesy of Motor Publications)

information is there when you need it. Compilation manuals are often broken down and sold in specialized sections. For example, like OEM specialty manuals, compilation manuals are available for just wiring diagrams and part location information for one make of vehicle.

One of the disadvantages of compilation manuals is the increasing size and weight of the books. For example, a collection that dates back even five years can easily fill a shelf, and that's despite the wiring diagrams being a fraction of their original size. Also, due to the downsizing, it can be hard to read some of the fine print. The biggest disadvantage is that it's hard to change material once it's set in print. If a manufacturer decides to change the color of a circuit wire after the printing deadlines, it may not get in the compilation manuals.

MICROFICHE

The increasing sizes of the compilation manuals led to books being recorded on microfiche. A microfiche is a small sheet of film with reduced photographic images arranged in rows and columns. The only equipment needed is a shoebox-size file box and a microfiche reader *(see Figure 2).* The reader can also be equipped with a printer. You can't buy just electrical diagrams. Part locator lists are included, but not part locator diagrams, which are difficult to reproduce on microfiche.

Besides the smaller size, one advantage microfiche has over books is durability. It's hard to remove grease from a printed page, but you can wipe microfiche film with a clean towel. On the downside, it's not as easy to page through microfiche sheets as it is to thumb through a book. Also, the

Figure 2-Having technical manual information on microfiche is one way to save space. All that's needed is a microfiche reader and a shoebox-sized file. A printer is also handy, if you want to take a diagram to the vehicle. (Courtesy of Mitchell International)

image on a reader screen may not be as clear as in a book. Due to differences among microfiche, you may need several lens sizes for your microfiche reader. You'll also need a good-quality, plain-paper printer to get a readable copy. If you don't have a printer, you won't be able to make a paper copy of a wiring diagram, to highlight circuits or take to the vehicle. Microfiche is now gradually being replaced by CD-ROM technology.

CD-ROM

The development of compact disc technology (CD-ROM) is a perfect match for service manual information. Now, entire libraries can be stored on a few compact discs. Usually, these discs are updated quarterly. You don't have to be knowledgeable in computers to operate this type of system. One system allows you to walk through the menus with a mouse *(see Figure 3).* Another offers a light pen to simply point at what you need on the screen *(see Figure 4).* One type of system allows you to use the CD-ROM discs on any IBM-compatible computer, by purchasing a CD-ROM drive. Another requires a computer package dedicated to running the CD-ROM system.

Figure 3-This CD-ROM system works with a mouse. The system uses a dedicated computer, monitor and printer. (Courtesy of Alldata)

The advantages of working with electrical diagrams on CD-ROM are space savings, easy access any time you need it, and durability of the discs. Like audio CDs, the discs are stored in a plastic case and will take some abuse. The main disadvantage is the initial cost of the computer equipment. Also, electrical diagrams are not available separately, so you have to buy into the whole system, whether or not you need the other service information. The screen images and printouts can be fuzzy if your computer equipment isn't the best. A high-quality monitor and printer minimize this problem.

MODEM SERVICES

If all you need is an occasional diagram, a modem service is another option. Receiving information "on-line" is a relatively new service. It requires an IBM-

Continued–Page 10

Figure 4-This CD-ROM system offers a light pen as an option. You simply point to what you want on the computer screen to walk through the menus. (Courtesy of Mitchell)

compatible computer, mouse and a highspeed modem. A separate phone line for your computer is recommended. You'll also need the software to get the program up and running.

Modem services are always available. When you call the service, you must enter the year, make, model, and engine type of the vehicle you're working on. If you know the problem, and only need the diagrams, you can narrow the search quickly using a series of menus. You can search for the problem area by circuit name, ground or power. It you're not sure what circuit is at fault, you can search by listing a category or symptom code. Once you find the diagram, you simply print it out on your own printer *(see Figure 5).* With this service, you're charged by the minute.

Advantages of an on-line service include easy access any time of the day or night. The information is easy to update, since changes from the manufacturer don't have to be sent to individual subscribers. As in the case of a hotline, you're not explaining the problem to another technician. This is an advantage if you know what you're looking for, but could be a problem if you don't. The system can also be costly up front if you don't already have the required computer equipment.

HOTLINES

Information is a phone call away with technical "hotline" services. Most of the sources already discussed have product support lines, in addition to their regular services, to help you when you run into problems using their information systems. Some of these sources also have separate hotlines for helping their customers through diagnostic problems. Each charges a subscription fee.

There are also independent hotlines. These services have "master" technicians to help you with your diagnostic problem. They try to solve your problem from their own experience using a computer database or other resource *(see Figure 6).* With this service, you're charged by the minute. One is set up simply to give you access to the master technician so you won't need any specific manuals or special diagnostic tools. It's not a source for wiring diagrams or other manual information. With another, if you already know the problem, and just need a wiring diagram or part locator list, the diagrams can be sent to you immediately by fax. These services are not designed for use as a last resort. Success with a hotline service relies on calling for help before you've spent a lot of time and replaced a lot of parts. Different subscription packages are available depending on how often you plan to use the service.

Figure 6–Technical hotlines allow you to discuss your diagnostic problem with a technician who has access to factory information. Hotlines can also be a source of wiring diagrams, using a fax. (Courtesy of Autoline Telediagnosis)

The advantage of any hotline service is that it can connect you with someone who is familiar with the vehicle you're working on, and maybe even your specific problem. Many electrical problems are unique, however, and it can take time for the master technician to

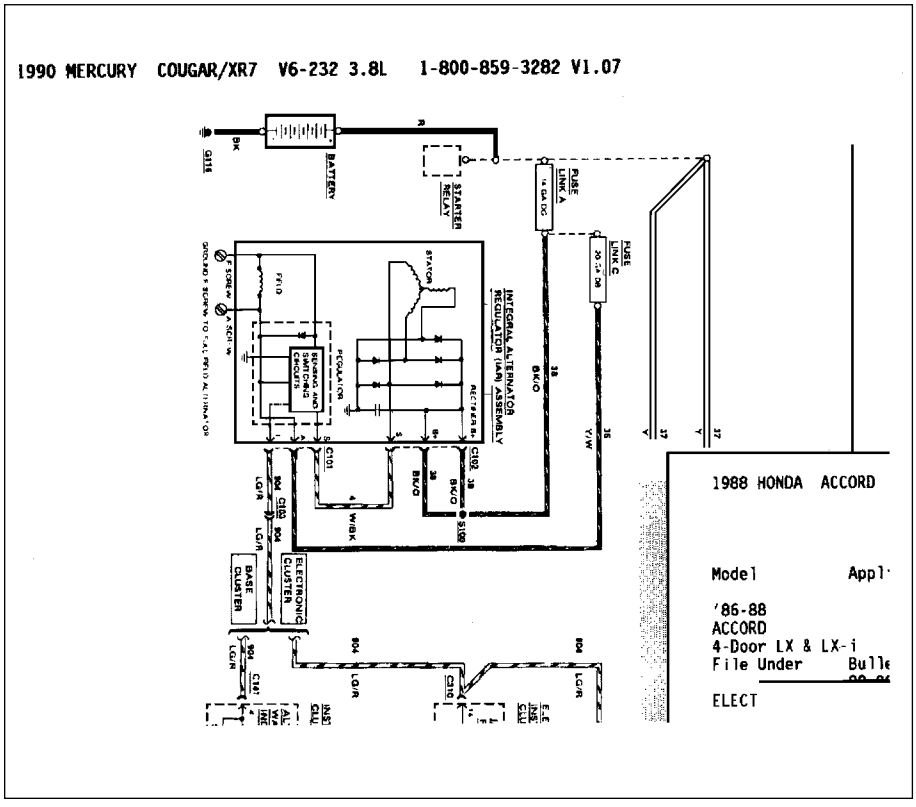

Figure 5–Wiring diagrams or part locator diagrams are available by modem. The system requires a modem and the company's software. (Courtesy of Alldata)

determine where you are in the diagnostic process, or whether your diagnosis to that point is correct. For example, you might think the problem is a faulty computer, while the real problem is a bad ground, several steps back in the flow chart. These services say that typical repairs done by telephone take 10–15 minutes, if everything goes relatively smoothly.

One concern with any hotline service is the hours of operation. The service might not be available if the problem comes up at an odd hour, weekend or holiday. This is when you could use a computer service, which never takes a holiday.

If you have a computer and a modem, one of the real advantages of a hotline is that they offer an option of actually sending them your scan tool readings via modem. Then the repair technician and master technician can use the same data.

LOCAL DEALERSHIPS

The parts department at the local dealership can be a valuable source of information, especially for the latest technical service bulletins. This is the basis for a relationship with the parts manager. The department has access to the OEM manuals, at least on computer, if not on the shelf. You probably don't want to make a habit of visiting the dealership for diagrams, but it can be a source in a difficult situation.

CONCLUSION

If you don't want to sublet electrical repairs, you're going to need sources of information. That is the first problem you face after getting the needed training. The need for more specific electronic information will become greater each model year. This need includes trouble code references and diagnostic specifications, like frequency response and temperature readings. More vehicle systems are moving toward self-diagnostics, and every vehicle manufacturer has a different system. The trouble codes point to possible cures for the problem symptom, but they are of little use without a manual. A